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Microscopy system and microscopy method for plural observers

Field of the invention

The present invention relates to a microscopy system and a microscopy method for plural observers.

In particular, the present invention relates to a stereomicroscope, such as a surgical microscope, for plural observers, or a microscope for plural observers which may be used for different purposes such as applications in material sciences.

Background of the invention

From US 6,327,079 B1 there is known a surgical microscope having separate ocular systems for two observers wherein respective oculars may be pivoted or rotated about an optical axis of an objective lens of the microscope.

There is an increasing demand for superimposing an electronically generated image with an image generated with the optical beam path of such microscopes. A problem encountered in some conventional applications is a lack of correct registration of the light optically generated microscopic image with respect to the superimposed electronically generated image.

Summary of the invention

Accordingly, it is an object of the present invention to provide a microscopy system and a microscopy method allowing an improved registration of the light optically

generated microscopic image with respect to the electronically generated image.

The invention provides a microscopy system for observing an object which may be positioned in an object plane of the microscopy system, wherein the system comprises at least one objective lens arrangement for receiving a beam on an object side of the objective lens and emanating from the object plane, and for transforming the beam of the object side into a beam on an image side of the objective lens. The system comprises plural ocular systems each having at least one ocular tube for generating plural respective images of the object plane for plural observers, and wherein an image projector having a display is provided for superimposing an image of the display with a beam path of the ocular system such that the image of the object plane is perceived by the respective observer superimposed with the image of the display. At least one optical setting of a first ocular system among the plural ocular systems may be adjusted independently of a corresponding optical setting of a second ocular system among the plural ocular systems. A controller is provided for generating the image displayed by the display, wherein the controller is configured to generate the displayed image from a first input image based on the at least one optical setting of the first ocular system.

With such system the observer may change the optical setting of the first ocular system, and the system will adapt the generation of the electronically generated image such that both the optically generated image and the electronically generated image are superimposed with each other as intended.

According to a first embodiment the at least one ocular tube of the first ocular system is rotatable about an

optical axis of the objective lens arrangement, and the controller is configured to generate the displayed image from the first input image by rotating the first input image by an image rotation angle determined on the basis of an angular position of the ocular tube about the optical axis.

According to a second embodiment the ocular system comprises a zoom system for changing a magnification of the optical image of the object plane, and the controller is configured to generate the electronically generated image displayed by the display from the first input image by scaling the first input image by a scale factor determined in dependence of the magnification of the zoom system.

The first input image may be an image having a direct correspondence with the observed object. For example, the first input image may be an image obtained by a further image generating method, such as a computer tomographic (CT) method, a magnetic resonance tomographic (NMR) method, and a fluorescence imaging method. The first input image may be previously generated from such three-dimensional tomographic data while taking into account a position of the microscope relative to the object under examination. It is then possible to adapt such input image to the present configuration of the optics for light optical observation of the object. Such present configuration may involve different settings of the rotational position of the ocular tube which the observer uses to observe the object or a currently used magnification of the zoom system of the ocular tube used by the observer.

The first input image has the correspondence to the light optically generated image in that structures and topologies of the light optically generated image correspond to structures and to topologies of the first input image. For

example, the first input image may represent a periphery of a structure, such as a blood vessel or a tumour tissue, with a high contrast, wherein the blood vessel or tumour tissue is contained in the light optically generated image with a lower insufficient contrast.

According to a further embodiment a second input image is superimposed with the light optically generated image wherein the second input image is independent of the at least one optical setting of the first ocular system, such as the setting of the angular position of the ocular tube about the optical axis of the objective lens or the magnification of the zoom system. The second input image may be an image representing suitable data of interest for the observer, such as information on a blood pressure of a patient under surgery, or others. Such data should be visible to the observer always in a same manner and independent of the optical setting of the ocular system.

The second input image does not directly correspond to the light optically generated image in that structures and topologies of the second input image do not correspond to structures and topologies of the light optically generated image. The second input image thus represents information which is preferably not in direct correspondence with the light optically generated image. The second input image may represent data numerically or as a bar diagram or some other graphical representation.

The invention further provides a microscopy method for displaying a magnified image of an object plane for plural observers, wherein the method comprises: light optically generating the images of the object plane with plural optics, wherein a first optics of the plural optics has at least one optical parameter which may be adjusted independently from corresponding optical parameters of the

other optics; electronically generating at least one representation from a first input image based on the at least one adjustable optical parameter; and superimposing an image of the electronically generated representation with the image of the light optically generated image generated with the first optics.

According to an embodiment of the microscopy method, at least a portion of the first optics may be rotated about an axis, and the electronical generation of the at least one representation comprises rotating the representation in dependence on an angular position of the portion of the first optics about the axis.

According to a further embodiment of the method, the electronical generation comprises scaling of the representation in dependence on a magnification of the first optics.

Brief description of the drawings

Embodiments of the invention will be illustrated herein below with reference to figure 1 showing a schematic representation of an embodiment of a microscopy system according to the present invention.

Detailed description of preferred embodiments

Figure 1 shows a schematic illustration of a microscopy system 1 having an objective lens system 3 including a lens system 7 and a housing 5 thereof. The lens system 7 has an optical axis 9 and receives an object side beam 13 emanating from an object plane 11 and transforms the object side beam 13 into an image side beam 15 which is a parallel beam in the embodiment shown in figure 1. However, the image side beam 15 may be also a non-parallel beam.

A beam deviding prism 17 is disposed in the image side beam 15 for splitting the image side beam 15 for two observers:

A first observer having a left eye 19L and a right eye 19R looks into a binocular tube 21 for perceiving a magnified image of the object plane 11, and a second observer having a left eye 23L and a right eye 23R looks into a binocular tube 25 for also perceiving a magnified image of the object plane 11.

The ocular tube 21 comprises two single tubes each having an ocular 29 and a zoom system 31 including two zoom lenses 33 and 34 which are displacable with respect to each other for changing the magnification.

Similarly, the binocular tube 25 comprises two single tubes each including an ocular 35 and a zoom system 37 having zoom lenses 39 and 40 which are displacable with respect to each other for change of magnification.

In a beam path between beam dividing prism 17 and the binocular tube 21 plural prisms 32 are provided for guiding the divided image side beam 15 to the binocular tube 21 and for allowing further rotations of the oculars 29 about beam 15 in a conventional manner.

In a beam path between the beam dividing prism 17 and the other binocular tube 25 prisms such as image reversing prism 43 are provided. The beam dividing prism 17 is rotatable about optical axis 9 with respect to the objective housing 5 such that the first observer with his eyes 19L, 19R may change his position about the optical axis 9. A position sensor 47 is provided for determining an angular position α1 of the beam dividing prism 17 relative to the objective housing 5.

Similarly, the prism 43 is rotatable about the optical axis 9, and a position sensor not shown in figure 1 for simplicity is also provided for detecting an angular position $\alpha 2$ of the prism 43 about optical axis 9.

A displacement sensor 49 is provided for detecting an adjusted magnification V_1 of the zoom system 31 as a function of a distance between the two zoom lens components 33 and 34. A corresponding displacement sensor 51 associated with the other zoom system 37 is provided for detecting a magnification V_2 to which zoom system 37 is adjusted.

An image projector 53 is provided in the beam path of the first observer for coupling an electronically generated image into the beam path to the left eye 19L of the first observer and for superimposing the electronically generated image with the light optically generated image of the object plane. The light optically generated image is formed by the optical components 7, 17, 42, 31 and 29 illustrated above. The image projector 53 comprises an LCD-display 55, an adapter optics 57 and a semi-transparent mirror 59 mounted on tube 21.

Similarly, an image projector 61 is provided in the beam path for the second observer, wherein image projector 61 comprises a pair of projectors such that an electronically generated image is supplied to both eyes 23L and 23R of the second observer. Image projector 61 comprises a pair of LCD-displays 55, a pair of adapter optics 57 and a pair of semi-transparent mirros 59 mounted on tube 25.

A controller 65 is provided for generating the images to be displayed by the image projectors 53 and 61. The controller is to generate the electronically generated images for image projectors 53 and 61, respectively, such that the

superposition of the respective electronically generated images is in accordance with the light optically generated images perceived by the respective observer. Thus, the generation of the electronically generated images has to be performed while taking the magnifications V_1, V_2 of the respective zoom systems 31 and 37 into account, and by taking the respective angular positions $\alpha 1$, $\alpha 2$ of the observers about optical axis 9 into account.

The image to be displayed is composed of two components, namely a first input image 67 and a second input image 69. The first input image 67 includes a representation of a structure determined by a computer tomographic (CT) method, such as a tumour tissue which is represented as a kidney-shape in figure 1. The second input image 69 comprises a data representation indicating a status of the patient under surgery with the microscopy system 1, such as a blood pressure, a pulse frequency and an oxigen saturation of blood or similar. The data representation is symbolically indicated by the number "17.4" in figure 1.

The data representation of the second input image 69 should be perceived by each observer always in a same manner, i.e. in a same size and orientation, and independently of the angular positions $\alpha 1$, $\alpha 2$ about the optical axis 9 of the objective lens 3, and independently of the currently adjusted magnifications V_1, V_2 of the respective zoom systems 31, 37.

The first input image, however, should be always superimposed with the light optically generated image of the object plane 11 such that the structure of the first input image corresponds to the structure of the light optically generated image, and the displayed first input image is changed when the angular position $\alpha 1$, $\alpha 2$ and magnification V_1, V_2 have changed. For this purpose,

controller 65 comprises for each observer an image rotating unit 71 to which the input image 67 is supplied. Further, the respective angular position $\alpha 1$, $\alpha 2$ detected with the respective position sensor (47) is supplied to the respective image rotating unit 71. The image rotating unit 71 rotates the first input image by the respective rotating angle $\alpha 1$, $\alpha 2$ and outputs the result as a rotated input image 73.

The controller 65 further comprises for each observer an image scaling unit 75 receiving the rotated image 73 as an input, and further receiving the magnification V_1, V_2 adjusted by the respective observer and detected by position sensors 49 and 51 respectively. The image scaling unit 75 scales the rotated image 73 in dependence of the magnification $V_{1,}$ V_2 and outputs the result as a rotated and scaled image 77 which is not separately shown in figure 1 for ease of illustration. The rotated and scaled image 77 is supplied to an image combining unit 79. The image combining unit 79 further receives the second input image 69 as an input and superimposes the second input image 69 with the rotated and scaled image 77. The result is outputted as an electronically generated image 81 to be displayed.

The electronically generated images 81 are supplied to the respective LCD-displays 55. The LCD-displays 55 display the electronically generated images 81 such that each observer perceives a superposition of the light optically generated image of the object plane, the second (data) input image 69, and the first input image 67 correctly oriented and scaled to correspond with the optical setting with which the light optically generated image is generated.

With the microscopy system 1 illustrated above it is possible that each observer perceives an electronic

representation having a direct correspondence with the observed object correctly oriented and scaled to coincide with the corresponding light optically generated image of the object. The electronic representation which is not in direct correspondence with the light optically generated image, such as a the data "17.4" is perceived always in the same way and independent of the orientation and magnification of the respective binocular tube.

In the embodiment illustrated above the electronically generated representations are superimposed with the beam paths of two observers. It is, however, possible to modify the microscopy system such that a higher number of observers is supplied with both the light optically generated images and the electronically generated images superimposed with correct orientation and scaling. It is further conceivable that only the second input image 69 is displayed to one or plural observers or that only the first input image 67 is displayed to one or plural observers or that only a subset of the plural observers may see both input images 69 and 67.

According to an alternative embodiment an image rotation angle and a scale factor may be determined by a method of image processing rather than by position sensors 47, 49, 51:

For this purposes, the beam paths for each observer comprise a CCD-camera 91, a camera optics 93 and a semi-transparent mirror 95 such that the camera is supplied with and detects an image of the object plane 11 similar to that image perceived by eyes 19R, 19L, 23R, 23L of the observers.

The controller 65 is supplied with an electronic representation of the images detecting by cameras 91, and

the controller compares these images with each other. From the comparison of the images the controller 65 may then detect a difference of the magnifications choosen by the observers. From such comparison, the controller may further determine a difference in the angular positions of the respective observers about the optical axis of the objective lens. Thus, the controller may determine the optical settings without mechanical sensors 47, 49, 51 by a mere electronic comparison of images, provided that only one of the magnifications V_1 or V_2 and one of the angles $\alpha 1$ or $\alpha 2$ are determined by some other method.

In the embodiment illustrated with reference to figure 1 the electronically generated image is supplied only to the left eye 19L of the first observer while his other eye 19R is not supplied with an electronically generated image. It is, however, also possible to supply both eyes 19L and 19R of the first observer with electronically generated images as it is illustrated for a beam path of the second observer receiving electronically generated images with his both eyes 23L and 23R.